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Mental Abilities in Cross-Cultural Context.

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Discussed are issues involved in testing the mental abilities of nonWestern, nonurban ethnic groups. Within this context the paper reviews conceptions of intelligence and intellectual potential, prediction under fixed and adaptive conditions, the question of environmental influences, and some formal test factors. Examples are drawn from African populations and Canadian Indian-Metis and Eskimo groups. (NH)

# Mental Abilities in Cross-Cultural Context

R. S. MacArthur, University of Alberta

(Paper presented to Department of Psychology Colloquium, McGill University, Montreal, March, 1966.)



## I. Problem

What is often called "Africanisation" of industry and government in Africa, together with wide extension of schooling, have underlined the need for modifying traditional Western-oriented selection, training and teaching procedures, in order to capitalize on the intellectual potential of candidates or pupils from quite different backgrounds. The development of personnel and resources of the Canadian North presents a similar problem. But -

1. How can one economically assess the intellectual potential of pupils or candidates for employment from cultures differing widely from ours, to assist in adapting teaching or training to that potential?

In fact, what is meant by intellectual potential in such contexts?

2. And to what extent do particular environmental conditions affect the development or lack of development of particular human abilities?

Such questions represent, I think, one of the major psychological problems of the second half of our century. - The applied problem of helping developing nations who are for the most part aiming to build up technological civilizations resembling the European-American, to select and train the requisite professional and skilled manpower; and its complementary theoretical problem of how particular environments interact with particular abilities as these abilities develop in young people.

My own focus concerning these two questions has been mainly upon pupils about nine to fifteen years of age, who may have widely differing cultural backgrounds, but who have attended school for at least two years. To help remind you of the kinds of kids and settings, I have a few slides. Since you are not interested in a travelogue today, my oral comment will be minimal. (Some Arctic and African slides here).

## II. Rationale

The rationale adopted in this paper to help guide investigation of such questions presents a conception of intelligence and intellectual potential, distinguishes between prediction under fixed treatment and under adaptive treatment conditions, suggests some ways in which environmental influences may be conceptualized, and points to certain formal test factors.

### 1. Nature of Abilities and Potential

(a) Hierarchical Organization. First, to use Thomson's (1951) phrase, intellectual abilities may be conceived "as if" usually correlated in a hierarchical model. At the top of the hierarchy is general intellectual ability, similar to Spearman's g but psychologically a kind of all-round average of our thinking abilities, and like other abilities at any time in a person's life the resultant of interaction between innate predispositions and experiences up to that time. Further down in the hierarchy are group factors (verbal, numerical, spatial, reasoning, etc), some emphasizing content, some processes or operations, and some products, of various degrees of generality depending upon the tasks and persons used in defining them. This hierarchy may be further subdivided into an almost unlimited number of increasingly specific abilities (Vernon, 1965).

Slide 33 presents Guilford's (1959, p.100) sketch of a hierarchical model of personality organization, and he goes on to point out the value of such a model in that different technologists can interest themselves in traits at the various levels, depending on which ones they find useful. Slide 34 presents my own 1950 sketch of a hierarchical model of personality and Slide 35 presents Vernon's (1965) diagrammatic representation of the general and main group factors that emerge most consistently when large and varied batteries of tests relevant to educational and vocational achievement are applied to representative samples of adolescents of European-American backgrounds.

(b) Development, Learning, Transfer. But up to this point the model is quite static. Second, then, patterns of individual differences in abilities develop, by a sort of cumulative transfer, through the interaction of innate predispositions and environment in a multiplicative manner. Both Hebb (1949) and Piaget (1964) have emphasized the importance of sensory-motor and perceptual associations of early childhood (early phase sequences or schemata) in forming the essential bases of all cognitive abilities. Differential experiences and learning are influential as cognitive abilities develop from these bases through a succession of Piaget-type stages. These stages are by no means discrete, and it is yet by no means clear the extent to which the approximate age of their appearance depends upon a particular cultural setting.

Ferguson (1954) has considered abilities to be overlearned skills for coping with problems, which have arisen from the child's previous experience and which can be transferred to a wide variety of new situations. Gagné (1961) sees learning sets arranged as a hierarchy of habits, with the more specific basic abilities becoming of less importance as more general learning sets emerge from them through positive transfer. Hunt (1961) sees a hierarchical model, with something akin to Spearman's g at the apex, as precisely what would be expected from considering abilities as the cumulative effects of transfer of learning in varied situations.

In the language of Inhelder and Piaget (1964) operations are a continuation of actions, which express certain forms of co-ordination which are general to all actions. Both pre-operations and operations enter into the most diverse kinds of behavior and are general in application. And though the development of operations is much dependent on perception, on language, and on maturation, operations in time take on an autonomy which transcends the original factors through which they developed. Reversibility, a flexibility of hindsight and foresight, is the most general characteristic of operations as a whole.

Two points would seem to emerge concerning the relationship between a static hierarchical model of the organization of abilities, and theories of the dynamic development nature of abilities. (i) As Ferguson (1954) suggests, since cultural influences prescribe what should be learned and at what age, different cultural environments can lead to the development of different patterns of abilities and at different ages. The patterning of abilities may vary considerably from culture to culture, and the degree, form, and correlates of this variation can be a matter for empirical cross-cultural research. (ii) The more nearly specific abilities, low in the hierarchy,are much dependent upon particular experiences which the child may or may not have had. General intellectual ability, at the top of the hierarchy, since it may be explained in terms of extensive positive transfer through highly generic coding systems, in Bruner's (1957) sense, will be less influenced by particular learning from a particular environment. Its assessment from a context of European-American psychology should be possible with less cultural bias than that inherent in assessing abilities lower in the hierarchy.

(c) Present Proficiency and Present Potential. Third, it may be useful in considering abilities to distinguish between three related ways in which the word intelligence is used.

Intelligence A - the innate substratum of predispositions of an individual upon which intelligent behavior is developed, a la Hebb. Attempts at its assessment are of little practical value until such time as control of environment from the moment of conception onward is feasible.

Intelligence B - the present level of proficiency in intellectual functioning of an individual, again a la Hebb. Differences in scores on tests of Intelligence B will be influenced by hereditary differences, by differences in opportunity to develop intelligence, and by cultural bias in the tests used.

Intelligence A'- (suggested by West, a student of mine) the present pot-

ential of an individual for future development of intelligent behavior, assuming optimum future treatment adapted to bring out that potential. It is upon Intelligence A', according to most philosophies of education, that teaching should be adapted so as to make the most of the present potential of the Metis pupil or young African employee before you. This requires an operational definition of Intelligence A', of present potential.

2. Fixed Treatment and Adaptive Treatment Prediction

But first let us note the distinction made by Cronbach and Gleser (1965) between prediction under fixed treatment conditions (where the man is expected to fit the training), and prediction under adaptive treatment conditions (where the training is expected to fit the man). When curricula and teaching methods, in school or industry, are relatively fixed a priori and we are predicting success in attaining immediate and rather specific goals, empirical predictor - goal correlations and expectancy tables, without theorizing about what is being measured, may be quite satisfactory.

But to the extent that we can implement a philosophy calling for teaching procedures and curricula so adapted as to maximize realization of the present intellectual potential of individuals, and if we are attempting to predict to distant and general goals, theoretical consideration of constructs likely to be involved in predictor-goal relationships becomes useful, perhaps definitely necessary. Hence the need for criteria for the construct validity of measures of present intellectual potential.

In the light of the foregoing, I have suggested nine criteria for measures of Intelligence A' for persons from cultures other than ours, the three chief of which are: (a) high loading on a general intellectual ability factor, (b) minimum bias against persons from non-middle-class urban European-American societies, and (c) moderate correlation with concurrent school achievement or trade efficiency.

It is sometimes questioned whether criteria and tests stemming from concepts of European-American psychology and education have any place at all in the context of newly developing countries and peoples. But most such peoples have aspirations in the direction of western technological civilization; it can be argued that development in that direction will require native personnel with, at least in a general way, western-type abilities.

3. Nature of Environment

Up to this point this paper has been using the word "environment" in a very loose way. To make any progress with the second question with which we began, namely how various environments affect the development or lack of development of various abilities, we will need to be more explicit about what we mean by environments. (Anastasi, 1965).

Certainly much research using varied approaches has been conducted concerning relationships between bits of environment and abilities. But as Bloom (1964) points out, in the delineation of even the main dimensions of environment as it may influence abilities, a great deal needs to be done; and in the matter of measuring devices, he notes that our catalogue of tests of individual differences is enormous, but our instruments for measuring environmental differences are limited to a few crude techniques such as those we use for measuring social class status. Bloom suggests that factorial research which has proven useful in the identification of the major dimensions on which individuals differ may prove equally useful in defining the dimensions on which environments differ. But much more research is needed to develop precise descriptions and quantitative measures of environments as they relate to the development of intelligence.

To the present writer this suggests that just as with abilities, so with environments, a hierarchical model may be quite useful in describing the organization of environments, and in entering the hierarchy at such levels

of generality as may be useful in a particular investigation. Thus, in many investigations it might be desirable to measure and relate a number of relatively specific aspects of socioeconomic status to relatively specific abilities; in other investigations it might be advantageous to assess rather more general levels of social status and general values held by groups at such levels. But if our model of the organization of abilities is crude, very much more needs to be done in mapping out such a model concerning the way in which environments are organized, in so far as they affect the development of abilities.

In the interim, I have selected several major dimensions for assessment of environments based mainly on summaries by Vernon (1965) and Bloom (1964), both of whose summaries emerged from experience and careful review of reported research in this area. How each of these dimensions may most usefully be subdivided, how they themselves interrelate, and how they may be reliably measured, all in the context of environment-ability interactions, presents a large area of urgently-needed research. Here then, as I read Vernon and Bloom, are seven dimensions of environmental press which at this stage may be useful in considering relationships between particular environments and the development of particular abilities.

1. Cultural Stimulus. e.g. education of parents and siblings, parental interest in schooling, opportunities for varied direct experience with the world and for vicarious experience through books, television, etc., opportunities for generally rich perceptual and conceptual development.
2. Encouragement of Initiative and Curiosity, e.g. emphasis on conformity, obedience, tradition vs. encouragement of problem-solving, exploration, resourcefulness.
3. Language, e.g. debased home language, lack of facility in language of instruction, opportunities for enlarging vocabulary and for developing both elaborated and restricted languages (Bernstein, 1965), differing conceptual

and grammatical structures of native language and language of instruction.

4. Achievement Motivation. e.g. nature of intellectual and vocational expectations of and for child, extent to which school achievement is motivated by parents, nature of models for achievement motivation.

5. Planfulness, e.g. work habits emphasized, immediate gratification of basic biological needs vs. development of internal controls and rational thinking directed toward more distant goals, impulsive vs. rational climate of home.

6. Health and Nutrition. e.g. defects of nutrition during pregnancy of mother, malnutrition and debilitating diseases of child, sanitation, availability and use of medical care.

7. Schooling. e.g. qualifications of teachers, teaching methods discouraging initiative, teaching materials, length and regularity of schooling.

8. Other. And an "other" category reminds not only that generally important environmental variables may have been omitted from this list, but also of keen sensitivity on the part of the observer to unforeseen variables which may be highly influential in a particular situation.

4. Formal Test Factors

Test performance is also influenced by culturally-oriented characteristics inherent in the form of tests used, in the skills and attitudes involved in understanding instructions and forming responses appropriate to the specific test situation. Biesheuval (1962, 1965), Schwarz (1963) and MacArthur, Irvine and Brimble (1963) have set out principles for getting across Western-type tests to Africans, which in effect amount to making explicit provision for teaching every form of response that the testee is expected to make and reducing extraneous stimuli.

5. Recapitulation

To recapitualate, then, abilities have been conceptualized as organized in a hierarchy from relatively specific abilities at the bottom to general

intellectual ability at the top. The development of these abilities takes place by a sort of cumulative transfer as innate predispositions interact with environmental conditions. Since environmental conditions may differ considerably from one culture to another, so may the patterning and nature of abilities at all levels of the hierarchy. But abilities high in the hierarchy are less affected by particular environmental experiences, and hence measures of g with minimum cultural bias should provide least bad estimates of present intellectual potential. Of course, determination of appropriate adaptive treatment to develop that potential for an individual may also require assessment of quite specific present proficiences well down in the hierarchy.

Though environmental influences might also usefully be visualized as organized in somewhat similar hierarchical fashion, the patterning of such environmental factors as they might affect the development of abilities is far from clear. Seven tentative "group factors" in the environmental domain have been suggested.

The effects of formal test factors, which frequently distort results of unsophisticated testees when Western-type tests are adapted for use elsewhere, can be somewhat reduced by modifications in the form of the test and its administration.

## III. Some Illustrative Research

With this back ground in mind, we might now examine some data in the handout, focusing on our two original questions somewhat rephrased:

1. What abilities (or tests) are less affected by particular environments - and at the same time are highly loaded on a general intellectual ability factors? (these were main criteria suggested for measures of intellectual potential.)

2. What abilities (or tests) are more affected by particular environments - and what particular abilities are affected by what particular environments? (these data will only slightly nibble at the latter part of this second

question.)

Research which we have previously reported at meetings of the Canadian Psychological Association and elsewhere, concerned with a number of samples such as white Edmonton pupils of wide range in socioeconomic status, and Indian-Metis pupils at Fort Simpson, N.W.T. and Faust, Alberta, has provided evidence that such tests as Progressive Matrices, IPAT Cattell Test of g, and Lorge-Thorndike Nonverbal Intelligence Tests are significantly less correlated with socioeconomic status, and significantly less biased against the Indian-Metis, than are such conventional scholastic aptitude tests as the California Test of Mental Maturity, the Laycock Mental Ability Test, the Otis Beta, and the Detroit Beginning. At the same time, the former group of tests have consistently indicated high loadings on a general intellectual ability factor, leading to the conclusion that they might be considered as less bad measures of intellectual potential, as contrasting with present proficiency, than are cnnventional scholastic aptitude tests.

In the course of norming several of these culture-reduced (not, of course, culture-free) measures of intellectual potential, across the whole of the Mackenzie District, N.W.T., the analysis of Table IA in the handout was made. Table IA reports F-ratios for two-way analyses of variance on two culture-reduced tests for each of three age-groups (about 400 cases in each age-group). The ethnic factor has three levels: White , Indian-Metis, and Eskimo. The ethnic effect is highly significant in all instances, with almost no significant sex effect. Table IB, showing t-tests on various pairs of means, is striking. The Whites score consistently very significantly higher than the native peoples, but the Indian-Metis do not score differently from the Eskimo for either sex on either test at any of the three age-levels. The abilities measured by these tests do not seem to be differentially affected by whatever environmental differences are associated with Indian

vs. Eskimo upbringing,as they at present exist for pupils in the western Canadian Arctic.

The data of Table IIA, for a large sample representative of all of Zambia Form 2 Africans, bring a few more environmental variables and abilities into the picture. The first four tests, of technical abilities and interests, were developed by the American Institute for Research, mostly in Nigeria, and we were given permission to use them. The last five tests, of scholastic aptitude and achievement, were developed for African conditions by the South African National Institute for Personnel Research. Looking at the bottom row, one sees that there are few differences in mean ability or achievement between Rural and Urban Form 2 pupils, excppt that Urban pupils have more Mechanical Information while Rural pupils are high on Embedded Figures and Reading. There are no differences between Mission and Non-Mission schools in achievement, or in ability as measured by the perceptual reasoning tests, but Non-Mission are above Mission in the spatial, mechanical, and Mental Altertness tests. The males are consistently better than females in all tests except the perceptual reasoning tests, in which there are no sex differences. This is somewhat the reverse of what is often found in European-American settings. Membership of one of the five main native Language Groups of Zambia has only affected English Vocabulary and Spelling, endemic mechanical information, and Embedded Figures. The considerable provincial differences suggest much more intensive investigation, which at the moment however might be rife with political complications. (In this particular study provincial effects may be somewhat confounded with tester effects.)

Considering the tests by looking down the right-hand column, it is striking that Progressive Matrices shows no differences for any of the bases of classification. The greatest number of differences occur in the spatial

and mechanical tests, with Urban Non-Mission Males doing best on these.

In Table IIB, school subjects of the rather academic curriculum show highest loadings on the unrotated first principal factor. Of the standardized tests, those most nearly assessing the same general quality as the school examinations as indicated by both high first principal factor loading and communality are Mental Alertness, Mechanical Information, Progressive Matrice and Vocabulary.

Tables IIA and IIB taken together clearly suggest that for this sample, of the tests considered Progressive Matrices least badly meets two main criteria for a measure of intellectual potential, namely less effect by particular environmental influences together with relatively high loading in the general intellectual domain. These tables have also indicated some abilities more affected by particular environments and in a vague way some of the environmental influences that may be affecting them. But in this regard they have raised questions crying out for more intensive investigation of "why?".

Returning to some of our Canadian native peoples, I am now in the midst of data analysis for 431 Eskimo, Indian-Metis and White pupils from Inuvik, Tuktoyaktuk and Faust, involving 15 samples with up to 100 variables each. Philip Vernon of the University of London has been studying 50 of these Eskimo boys intensively, his battery including 13 Piaget tasks, some "creativity" tests, and a number of environmental variables. I have replicated much of his individual battery with 54 of the Indian-Metis.

Table IIIA reports some preliminary results for 87 Eskimo age 9 to 12. The first column shows that when the Eskimo are combined with a group of Whites of the same age, the first ten tests have relatively low correlation with White-Eskimo, while at the same time having high loadings on the first unrotated principal factor and quite high communalities. Tests 11 to

16 have higher correlation with White-Eskimo; for example, the Otis-Ethnic r of .46 is significantly higher than the Progressive Matrices-Ethnic r of .25 (p less than .05). For the 87 Eskimo by themselves the column of non-significant correlations with Sex contrasts markedly with the general male superiority for Zambians. For the restricted range of occupations in the sample, there was a similar column of non-significant correlations with parental occupation.

The last five columns of Table IIIA show the promax oblique rotation of a varimax factor analysis solution. The first factor is the v:ed so often found. The second factor I label reasoning from nonverbal stimuli (not just nonverbal - testees usually verbalize considerably, perhaps in their native language, in working many of these items). At the bottom of the page the oblique primary factor correlation matrix shows an r of .63 between factors I and II, suggesting that both factors are tapping a general intellectual ability (but those loaded on factor II with less White-Eskimo bias).

Table IIIB presents a remarkably similar picture for older Eskimo pupils, except that the v:ed. tests now tend to favor the Whites even more - the Otis correlation with White -Eskimo is now .60.

Table IIIC, computed from some of Vernon's as yet unpublished data for his 50 Eskimo boys, further illustrates some White-Eskimo ability relationships. When the Eskimo boys are scored on Calgary White norms, the abilities showing least ethnic differences are those involved in 2D -to- 3D visual perception, Embedded Figures, Abstraction, and Porteous Mazes. The high Eskimo scores on 3-D Perception are especially interesting, since Africans usually find extreme difficulty with this kind of task. Abilities showing most White-Eskimo differences are those concerned with vocabulary, especially oral English. This would seem to suggest more emphasis in the curriculum for the Eskimo on oral expression and oral comprehension of English (a costly business).

Since my own analyses of more detailed relationships of environmental variables to abilities for the recent Eskimo and Metis samples are not yet completed, in Table IV I have presented one of Vernon's reported analyses for his Jamaican sample, which indicates some of the kinds of further analyses proceeding for the Canadian groups. Vernon first factor analyzed his 13 Piaget tasks by themselves, and then combined them into the two tests 8 and 9. His group factor analysis of his large battery of ability tests for the Jamaican boys indicated a large general factor running through all the ability tests. The v:ed factor ran through alot of spatial tests as well, suggesting that for these pupils it involves a facility in dealing with many sorts of symbolic material, probably together with ability to comprehend instructions. Some variance went to a perceptual factor.

Turning to the bottom part of Table IV, linguistic background appears to be the most important of the environmental variables, affecting g, v:ed, and perception. Cultural level of the home is similar, and is more important than socioeconomic rating; it is not so much the income as such, but the cultural atmosphere that is created with it, that affects development of abilities. Length and regularity of schooling is the next most important of the environmental variables. The remaining correlations may be considered in like fashion - as far as you wish to go with an N of 50 cases. (Replication data from other cultures are becoming available.)

IV. Discussion and Next Steps.

1. These data have thrown some light on our first question - on the kinds of tests (and perhaps abilities) less affected by membership in urban lower socioeconomic groups, or in Indian-Metis or Eskimo ethnic groups, or in various Zambian groups, while at the same time being relatively highly loaded on a general intellectual ability factor. These were two main criteria postulated for measures of intellectual potential with minimum cultural bias.

One might now ask - what is thereabout such tests as Progressive Matrices that helps them meet these two criteria taken together less badly than do conventional group so-called intelligence tests?

(Three slides of Progressive Matrices shown here.)

Three replies suggest themselves: (a) the items form something of an age-scale sampling stages in the development of human cognition, starting with perception-dominated items, and proceeding through reversible concrete operations, to propositional or formal operations; (b) they use as stimuli symbols, which though dependent on learning, are likely to be learned in a variety of cultures; (c) the arrangement of the items in the test itself forms a crudely-programmed sample of learning-on-the-spot; further, in using the Standard Progressive Matrices, we have of late preceded it with up to 30 minutes of teaching the Coloured Progressive Matrices, item by item, with Skinnerian checking and reinforcement for each item.

Continued basic and operational research in these three directions - ( (a) What <u>are</u> the essential features of the main stages in the development of cognition likely to be common across a variety of cultures? (b) What symbols <u>are</u> least likely to be dependent perceptually upon particular previous learnings from a particular environment? (c) How can we more efficiently program miniature cognitive learning situations, tapping the essential features of cognitive development, but using simple symbols?) should help us considerably with the practical problem of assessing the general intellectual potential of individual candidates from other cultures.

2. As for question two, and how particular environments affect the development of particular abilities, we have to-day only slightly nibbled at this huge question, and indicated some interesting pointers to areas crying out for much more intensive investigation. For example:

(a) Western tests adapted for use in other cultures tend to group themselves

in ways explainable in terms of Western constructs, but also there may be different sources of variance related to the particular culture in which the tests were given. Thus, specifically what differences in the upbringing of the sexes in the Arctic and in Zambia accounts for the relative lack of development of intellectual abilities of Zambian females but not of Arctic females (shown particularly in tests of vocabulary and information demanding social and scientific awareness)? Irvine (1966) has offered a very plausible explanation in terms of current pressures on and opportunities provided for Zambian males. Is this a temporary effect resulting from quite temporary conditions in a rapidly developing Zambia? How could similar development for females be fostered?

(b) Or again, specifically why is the Eskimo relatively high in 2D-to3D perception and the African relatively low? If this is a desirable ability in today's technological and diagrammatic world, how and when can it be trained?

Specifically, what in the life of the Non-Mission Urban Zambian Form 2 pupil raises his spatial and mechanical aptitudes above those of the Mission Rural Zambian, while for Embedded Figures the Rural-Urban position is reversed?

(c) Or again, the data have suggested that it is not so much parental income as such that affects the development of abilities, but rather the way income is used in raising the linguistic level, cultural atmosphere and interest in education of the home. These may affect general, v:ed, and perceptual abilities.

Abilities in oral expression and oral comprehension of English particularly seem to be held back by the environment of our native peoples. How can further experiences in oral English be economically provided, and what experiences at what stage are most important?

For written tests, Eskimo and Indian-Metis background reduces performance

in v:ed loaded tasks more than in tasks of reasoning from nonverbal stimuli. The deficit tends to be cumulative, but was not cumulative in our Fort Simpson study. Under what conditions does this v:ed deficit cumulate, and under what conditions does the deficit decrease?

3. In the appendix to this paper I have set out a whole sheaf of similar next steps in research in this area. Some are oriented toward abilites and their measurement, some toward environments and their measurement, some toward relationships between environments and the development of abilities, some toward intrinsic motivation, and some toward analysis procedures.

Now I have spoken today of certain environmental variables "affecting" the development of particular abilities, as though from a few factor-analyzed correlations and some differences of means as used here one could directly infer causes. Obviously comparative survey approaches need to be complimented with experimentally controlled treatments and longitudinal studies in attempts to steadily tease out causal connections. Problems of interaction, and of chicken-or-egg precedence, abound. But as Vernon (1965) says, we are on the verge of extremely exciting advances in the understanding and control of intellectual and personality development through such varied approaches as social learning and reinforcement theory, direct observation and follow-up of children, socioanthropoligical studies, and psychometrics. And I might add, sooner or later genetics and Intelligence A, as well as Intelligence A! and B, will have to be rehabilitated in this context.

Such cross-cultural studies should lead psychology to better understanding not only of the behavior of the frustrated Viennese woman, the white rat, and the American college freshman, but also of the behavior of <u>man</u>.

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# HANDOUT FOR 'MENTAL ABILITIES IN CROSS-CULTURAL CONTEXT"

R. S. MacArthur, University of Alberta

(Paper presented to Department of Psychology Colloquium, McGill University, Montreal, March, 1966).

## A OUTLINE

I. Problem - 1. How can one economically assess the intellectual potential of pupils or candidates for employment from cultures differing widely from ours, to assist in adapting teaching or training to that potential? In fact, what do we mean by intellectual potential in such contexts?
2. And to what extent do particular environmental conditions affect the development or lack of development of particular human abilities?

II. Rationale
1. Nature of Abilities and of Potential - (a) Hierarchy, (b) Development and Transfer, (c) Present Proficiency and Present Potential.
2. Fixed Treatment and Adaptive Treatment Prediction.
3. Nature of Environment.
4. Formal Test Factors.

III. Illustrative Research.

IV. Next Steps.

## B. SOME ILLUSTRATIVE DATA

### TABLE IA

Ethnic and Sex Differences, Mackenzie District, N.W.T., Norming Project
F-Ratios for Six Two-Way Analyses of Variance

| Age-Group | 8 to 9½ yrs. | | 10 to 12 years | | 12½ to 14½ yrs | |
|---|---|---|---|---|---|---|
| Test | Cld. Prog. Mat. | Otis Alpha NV | Std. Prog.Mat. | L-th NV Lev. 3 | Std. Prog.Mat. | L-Th NV Lev.4 |
| d.f. Within Gps. | 418 | 432 | 486 | 386 | 421 | 359 |
| Ethnic effect | 15.90** | 52.34** | 71.12** | 83.60** | 37.08** | 30.12** |
| Sex effect | 5.76* | .53 | 2.88 | 1.33 | .01 | .95 |
| Interaction | .33 | .87 | .19 | .52 | .04 | .83 |

* Sig. at .05 level
** Sig. at .01 level

### TABLE IB

t-Ratios for Thirty-Six Pairs of Individual Means.
Mackenzie District Norming Project

| Age-Group | 8 to 9½yrs | | 10 to 12 yrs. | | 12½ to 14½yrs | |
|---|---|---|---|---|---|---|
| Test | Cld. Prog.Mat. | Otis Alpha NV | Std. Prog.Mat. | L-Th NV Lev. 3 | Std. Prog.Mat. | L-Th NV Lev. 4 |
| Female, W. vs I-M | 4.16** | 7.59** | 7.49** | 9.06** | 5.43** | 5.03** |
| W. vs Esk. | 3.00** | 4.99** | 6.50** | 6.73** | 5.48** | 5.58** |
| I-M vs Esk. | 0.36 | 1.10 | 0.84 | 0.62 | 1.37 | 1.75 |
| Male, W. vs I-M | 3.20** | 6.60** | 6.99** | 7.72** | 4.81** | 4.60** |
| W. vs Esk. | 2.83** | 3.31** | 7.24** | 7.43** | 4.81** | 3.82** |
| I-M vs Esk. | 0.35 | 1.69 | 1.54 | 0.59 | 1.06 | 0.07 |

* Sig. at .05 level
** Sig. at .01 level

Northern Rhodesia Mental Ability Survey, 1963 was primarily concerned with providing basic data on concurrent and predictive validities of tests prior to establishment of an Aptitude Testing Unit. 2,671 Africans in schools, mines and government were tested. Main analyses thus concerned with norming, multiple correlation and expectancy tables. Data below illustrate some of side-analyses having relevance for topic of this paper.

TABLE IIA

Significance of F-Tests for Sixty One-Way Analyses of Variance
Zambian African Form 2 Sample
(Ten dependent variables each on six bases of classification)

| | Basis of Classification | | | | | | No. of Sig. F's |
|---|---|---|---|---|---|---|---|
| | Province | Rural/ Urban | Miss./ N.-M | Sex | Lang. Gp. | Tester | |
| 1. AIR Boxes | * | - | * | * | - | * | 4 |
| 2. AIR Mech. Info. 1&2 | * | * | * | * | * | * | 6 |
| 3. AIR Mech. Info. 3 | * | * | * | * | - | * | 5 |
| 4. AIR Figures | * | * | - | - | * | * | 4 |
| 5. Prog. Mat. | - | - | - | - | - | - | 0 |
| 6. N.B. Ment.Alert. | * | - | * | * | - | - | 3 |
| 7. N.B. Compre.Rdg. | * | * | - | * | - | * | 4 |
| 8. N.B. Vocab. | - | - | - | * | * | * | 3 |
| 9. N.B. Spell. | * | - | - | * | * | - | 3 |
| 10. N.B. Computa. | * | - | - | * | - | * | 3 |
| No. of Sig. F's | 8 | 4 | 4 | 8 | 4 | 7 | |

* F significant at .05 level
\- F not significant at .05 level

N=442 for each analysis of variance
Mean stated age = 17-7

TABLE IIB

Unrotated First Principal Factor and Communalities
Zambian African Form 2 Sample

| | Fact. I | $h^2$ to 9 factors |
|---|---|---|

Zambian African Form 2 Sample

| | Fact. I | $h^2$ to 9 factors |
|---|---|---|
| 1. Boxes | .38 | .40 |
| 2. Mech. Info. 1 & 2 | .49 | .60 |
| 3. Mech. Info. 3 | .45 | .65 |
| 4. Figures | .41 | .39 |
| 5. Prog. Mat. | .42 | .53 |
| 6. NB. Ment. Alert. | .65 | .57 |
| 7. NV..Compre. Rdg. | .38 | .33 |
| 8. NB. Vocab. | .55 | .44 |
| 9. NB. Spell. | .36 | .24 |
| 10. NB. Computa. | .40 | .42 |
| 11. SE Eng. 61 | .18 | .30 |
| 12. SE Arith. 61 | .36 | .43 |
| 13. SE Spec. 61 | .48 | .34 |
| 14. LE Eng. 61 | .48 | .47 |
| 15. LE Arith. 61 | .37 | .46 |
| 16. LE Geog. 61 | .59 | .52 |
| 17. LE Hist. 61 | .48 | .43 |
| 18. LE Sci. 61 | .45 | .33 |
| 19. LE Eng. 63 | .55 | .57 |
| 20. LE Math. 63 | .67 | .63 |
| 21. LE Geog. 63 | .66 | .70 |
| 22. LE Hist. 63 | .50 | .51 |
| 23. Rural-Urban | .03 | .77 |
| 24. Miss./N.-Miss. | -.22 | .67 |
| 25. Grade of School | .09 | .47 |
| 26. Age | .13 | .30 |
| 27. Sex | .44 | .81 |
| 28. Father's Occup. | -.11 | .23 |
| 29. Yrs. in Town | .07 | .37 |
| 30. No. Languages | -.06 | .20 |
| Prop. Tot. Var. | .18 | .47 |

TABLE III A

Correlations with Ethnic Status and with Sex,
and Factor Analysis
Inuvik - Tuktoyaktuk Eskimo Ages 9 to 12

| | Correlations | | Factor Analysis N=87 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | White/ Esk. N= 120 | Female/ Male N= 87 | Unrotated Factor I | $h^2$ | Promax Primary Factor Pattern (Coeffs. below .30 omitted) I v:ed | II N.V Reas. | III Sex | IV Voc. Plans | V Occ. Parent |
| 1. Embedded Figures | .07 | .01 | .68 | .63 | .80 | | | | |
| 2. Progressive Matrices | .25 | -.03 | .68 | .81 | .96 | | | | |
| 3. SCRIT | .26 | .04 | .57 | .55 | .81 | | | | |
| 4. MAC 2 | .25 | .03 | .61 | .64 | .38 | | | .51 | |
| 5. L-Th. NV 1 | .17 | .02 | .67 | .53 | .60 | | | | |
| 6. L-Th. NV 2 | .27 | .02 | .84 | .77 | .61 | | | | |
| 7. L-Th. NV 3 | .32 | .01 | .75 | .70 | .80 | | | | |
| 8. Cattell | .23 | -.15 | .73 | .73 | .85 | | | | |
| 9. Memory written words | .12 | .32 | .64 | .58 | .60 | | .55 | | |
| 10. Abstraction-vbl. induction | .26 | -.01 | .70 | .81 | .37 | .53 | | | |
| 11. Otis Beta | .46 | .11 | .74 | .67 | .79 | | | | |
| 12. Vocabulary, written | .38 | .16 | .80 | .75 | .81 | | | | |
| 13. Arithmetic | .41 | .11 | .91 | .89 | .80 | | | | |
| 14. English rdg., usage | .38 | .11 | .87 | .82 | .77 | | | | |
| 15. Oral Information | .39 | .06 | .79 | .70 | .66 | | | | |
| 16. Grade | .36 | .11 | .89 | .91 | .92 | | | | |
| 17. Age | .30 | -.16 | .47 | .77 | .68 | | | -.38 | |
| 18. Time in School | .13 | .04 | .64 | .57 | .77 | | | | |
| 19. Plans for age 20 | .27 | .01 | .31 | .66 | .32 | | | .82 | |
| 20. Occupation of parent | .74 | .07 | .24 | .84 | | | | | .94 |
| 21. Sex (Female high) | .05 | -- | .06 | .81 | | | -.96 | | |

Oblique Primary Factor Correlations

| | | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Factor | I. v:ed | — | .63 | .12 | .21 | .18 |
| | II. Reasoning from Nonverbal Stimuli | | — | .10 | .23 | -.35 |
| | III. Sex | | | — | -.19 | .31 |
| | IV. Vocational Plans | | | | — | .29 |
| | V. Occupation of Parent | | | | | — |

## TABLE IIIB

Correlations with Ethnic Status and with Sex,
and Factor Analysis
Inuvik - Tuktoyaktuk Eskimo Ages 12½ to 15½

| | Correlations | | Factor Analysis N=80 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | White/ Esk. N= 110 | Female/ Male N= 80 | Unrotated Factor I | $h^2$ | Promax Primary Factor Pattern (Coeff. below .30 omitted) I v:ed | II N.V Feas. | III Sex | IV Voc. Plans | V Occ. Parent |
| 1. Embedded Figures | .24 | .05 | .75 | .65 | | .62 | | | |
| 2. Progressive Matrices | .33 | .08 | .80 | .72 | .31 | .65 | | | |
| 3. SCRIT | .13 | .13 | .52 | .71 | | .85 | | | |
| 4. MAC 2 | .11 | .13 | .49 | .65 | | .74 | | -.41 | |
| 5. L-Th. NV 1 | .19 | -.14 | .61 | .56 | | .44 | -.35 | | |
| 6. L-Th. NV 2 | .26 | -.01 | .83 | .73 | .45 | .45 | | | |
| 7. L-Th. NV 3 | .30 | -.05 | .68 | .65 | | .69 | | | |
| 8. Cattell | .27 | -.13 | .48 | .67 | | .86 | | | |
| 9. Memory written words | .18 | .01 | .41 | .35 | | .36 | | | .39 |
| 10. Abstraction-Vbl.induction | .32 | .09 | .84 | .73 | .55 | .41 | | | |
| 11. Otis Beta | .60 | .22 | .85 | .81 | .80 | | | | |
| 12. Vocabulary, written | .54 | .09 | .73 | .71 | .93 | | | | |
| 13. Arithmetic | .45 | .08 | .89 | .83 | .80 | | | | |
| 14. English rdg., usage | .44 | .22 | .87 | .88 | .95 | | | | |
| 15. Oral Information | .43 | .09 | .72 | .62 | .78 | | | | |
| 16. Grade | .46 | .20 | .87 | .93 | .95 | | | | |
| 17. Age | .20 | .04 | .37 | .67 | .46 | | | -.63 | |
| 18. Time in school | .35 | .16 | .71 | .77 | .93 | | | | |
| 19. Plans for age 20 | .49 | -.04 | .37 | .62 | | | | .62 | |
| 20. Occupation of parent | .61 | .05 | .03 | .78 | | | | | .90 |
| 21. Sex (Female high) | -.11 | — | .11 | .79 | | | -.90 | | |

Oblique Primary Factor Correlations

| | | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Factor | I. v:ed | — | .56 | -.22 | -.03 | .19 |
| | II. Reasoning from Nonverbal Stimuli | | — | -.16 | -.05 | .13 |
| | III. Sex | | | — | .10 | -.05 |
| | IV. Vocational Plans | | | | — | .06 |
| | V. Occupation of Parent | | | | | — |

## TABLE IIIC

For Vernon's 50 Eskimo Boys Age 9 to 12 Years
Some Mean T-scores based on Calgary Whites
(Calgary Means are 50, S.D. 10, for each test)

| | | | |
|---|---|---|---|
| 3-D Perception | 49 | Arithmetic | 41 |
| Embedded Figures | 45 | English rdg., usage | 41 |
| Abstraction,vbl. induction | 45 | Memory written words | 41 |
| Porteous Mazes | 45 | Vocabulary,written | 39 |
| Formboard | 41 | Oral Information | 34 |
| Kohs Blocks | 41 | Vocabulary, oral | 33 |

Computed from preliminary unpublished data of P.E. Vernon

## TABLE IV

Tests Given by Vernon to 50 West Indian 11-Year Boys, Group Factor Analysis, and Correlations of Ability Factors with Environmental Variables

| Tests or Other Variables | g | v:ed | Perc. | Prac.? |
|---|---|---|---|---|
| 1. Arithmetic Attainment | ++ | + | | |
| 2. Spelling | + | + | | |
| 3. Memorizing lists of words | + | + | | |
| 4. English comprehn., usage, spelling | + | + | | |
| 5. Vocab. A, group multiple-choice | + | + | | |
| 6. Vocab. B,indiv. Terman-Merrill | + | | - | |
| 7. Memorizing oral information | + | + | | |
| 8. Piaget arith. - orientational | + | + | + | |
| 9. Piaget conserv.n.-visualization | ++ | | | |
| 10. Matrices non-verbal induction | ++ | | | |
| 11. Concept formation-sorting test | ++ | | | |
| 12. Porteous Mazes | + | + | | + |
| 13. Vernon Formboard | + | | + | + |
| 14. Kohs Blocks (WISC-Jahoda) | ++ | + | + | |
| 15. Goodenough Draw-a-Man | + | + | + | |
| 16. Gottschaldt (Embedded) Figures | + | | + | |
| 17. Reproducing Designs (from Bender-Gestalt and Terman-Merrill) | + | + | + | |
| 18. Picture Recogn.-3-D perception | + | + | | |
| 19. Length and regularity of schooling | .23 | .19 | .26 | |
| 20. Family pattern:unbroken vs. broken home | -17 | .24 | .14 | + |

| | | | | |
|---|---|---|---|---|
| 9. Piaget conserv.n.-visualization | ++ | | | |
| 10. Matrices non-verbal induction | ++ | | | |
| 11. Concept formation-sorting test | ++ | | | |
| 12. Porteous Mazes | + | + | | + |
| 13. Vernon Formboard | + | | + | + |
| 14. Kohs Blocks (WISC-Jahoda) | ++ | + | + | |
| 15. Goodenough Draw-a-Man | + | + | + | |
| 16. Gottschaldt (Embedded) Figures | + | | + | |
| 17. Reproducing Designs (from Bender-Gestalt and Terman-Merrill) | + | + | + | |
| 18. Picture Recogn.-3-D perception | + | + | | |
| 19. Length and regularity of schooling | .23 | .19 | .26 | |
| 20. Family pattern: unbroken vs. broken home | -17 | .24 | .14 | + |
| 21. Stable home background vs. frequent | .14 | .17 | | + |
| 22. Economic: parents' job, housing, equipment | .27 | .28 | | + |
| 23. Cultural stimulus: books in home, educ. of relatives, parent interest in educ. | .33 | .46 | .25 | |
| 24. Male dominance & identification vs. female over-protection or dominance | .25 | | .27 | |
| 25. Initiative and maturity encouraged in play and household activities | .27 | .16 | | + |
| 26. Planfulness: rational home climate vs. impulsive, emotional, arbitrary | .32 | | | |
| 27. Linguistic background | .47 | .41 | .28 | |
| 28. Child's health, physical development and nourishment | | .21 | .19 | |

Details available in P.E. VERNON, "Environmental Handicaps and Mental Development," British Journal of Educational Psychology, 1965, Vo.35

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